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Sustainable IT Case Study

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End User Computing in English Schools

English state funded schools consist of over 25,000 organisations with 16.1 million computer users. Consequently it represents one of the world's largest end user computing (EUC) communities. The Department for Education (DfE) recognises that sustainable use of technology has become increasingly important in schools because reducing associated energy consumption and carbon footprint directly supports the UK's broader sustainability goals and policies.

To understand school information technology (IT) footprint better and explore sustainability focused procurement methods, the DfE worked with Dr Justin Sutton-Parker and the University of Warwick to research school EUC asset data and to secure credible evidence on this potential.

Project Objective

The research determines a baseline for school's EUC device carbon footprint, e-waste, electricity consumption, utility and estimated procurement costs. Sustainable IT practices, such as lifespan extensions and introducing carbon footprint as a selection criterion, are then applied to demonstrate credible reductions that can be achieved for both the environmental and financial values.

Executive Summary

IT generates 5% of global greenhouse gas (GHG) emissions [1-4]. Efforts led by the United Kingdom's (UK) government's digital sustainability teams have generated policies, such as the Greening Government ICT programme, to tackle this issue. Historically the policies have focused on reducing IT energy consumption and more recently, examining IT supply chain impacts [5].

In line with the international sustainable development frameworks, national legislation and programmes designed to deliver net zero by 2050, it is the duty of the DfE to explore actions and strategies that will help the education sector to adapt to climate change.

To facilitate this, the DfE has worked with Dr Sutton-Parker, an expert in sustainable IT, and the University of Warwick to produce scientifically valid data outlining current and future environmental and financial impacts of EUC devices purchased and used in English state funded schools. The findings will be used to support the expansion of IT strategies designed to reduce carbon footprint, e-waste and energy consumption.

The results of the research project show that end user computing devices in the English state funded schools have a significant impact from both an environmental and financial perspective. Specifically, the annual carbon footprint is 429,060 tons of GHG emissions, costs are £1.15 billion and e-waste is 5,691 tons. In context, To remove this amount of IT carbon emissions from the atmosphere requires 19.5 million trees for every year of operation.

Further to modelling EUC device lifespan extension strategies and the introduction of carbon footprint as a selection criterion, the result finds that significant environmental and financial improvements are available. Primary, secondary and Special Educational Needs and Disabilities (SEND) schools have the opportunity to reduce 57% of EUC device carbon footprint, 34% of utility and procurement costs and 50% of e-waste.

When extrapolated to a national level, the proposed 8-year device retention period will avoid 1,954,217 tons of GHG emissions, £3.16 billion in costs and prevent 22,511 tons of e-waste.

In conclusion, should these findings and actions be incorporated into national sustainable IT guideline frameworks by the DfE and UK government sustainability teams, the positive impact to the planet, public purse and climate policy is undeniably meaningful.

Method

User obfuscated EUC asset data are captured by consenting school IT staff for a sample ≥ 1% of English state funded primary, secondary and SEND schools. Data includes a) static computers b) mobile computers c) personal computer monitors and teaching displays defined by device type, brand, model and quantity. School type (e.g. primary), regional location (e.g. East of England) and number of teachers, pupils and ancillary staff employed is also determined. An average cost per new device type is supplied by DfE IT advisors to enable modelling of potential reductions to annual procurement costs. The sample data was input into the Px^3 IT carbon footprint calculation and reporting application platform [6]. The tool was initially developed during PhD research conducted at the University of Warwick [1]. An EUC Baseline Report is generated for a) each organisation and b) each organisational group by type to generate specific and average existing (current) environmental and financial metrics. The process is repeated to create an EUC Sustainable IT Strategy Report for schools by type to demonstrate feasible reductions to environmental and financial metrics that can be achieved by adopting the proposed strategies. Results are summarised in this case study and presented in a 117 page report to the DfE and UK government sustainable IT groups in Autumn 2025. The research period was twelve months from July 2024 to June 2025 inclusive.

Results

233 schools participated in the research including 157 primary (67%), 69 secondary (30%) and 7 SEND schools (3%). Currently, within England's state funded education sector there are 16,764 primary, 3,452 secondary and 1,050 SEND schools [7] meaning the sample surpassed the required ≥ 1% threshold. Data was collected from schools located in 8 of the 9 regions of England (89%) representing 28 of England's 46 counties (61%).

The sample data identified 142,615 EUC devices including 124,194 computers (87%), 14,730 monitors (10%) and 3,691 (3%) displays used by 121,226 students (90%) and 12,943 teaching, support and administrative staff (10%).

This creates an average of 0.9 of one computer per user. Mobile type devices such as notebooks and tablets account for 87% of computers with static devices (such as desktops and AIO) accounting for the remaining 13%. The average age of static computers is 6 years, mobile computers 5 years, monitors 6 years and displays 5 years.

Current EUC Asset Profile in Schools

For the primary schools, 51,000 EUC devices are identified spanning 781 models from 55 brands. An average primary school has 348 computer users including 309 students (89%) and 39 (11%) staff. Each school has 322 EUC devices represented by 301 computers (94%), 13 monitors (4%) and 8 displays (2%). Specifically, the device portfolio consists of 156 tablets (48%), 130 notebooks (40%), 13 desktops (4%) and monitors, 2 AIO desktops (0.6%), and 8 interactive displays. 95% of computers are mobile devices and the average ratio of computers to users is 0.9:1, meaning almost one computer is available for every student. The average age of static computers is 7 years, mobile computers 5 years, monitors 7 years and displays 5 years.

Among the secondary schools, almost 88,000 EUC devices are identified with 607 models from 53 brands. An average secondary school is 3x larger than a primary school with 1,091 computer users. Of these, 999 are students (92%) and 92 staff (8%). Each secondary school has 1,274 EUC devices, including 1,075 computers (84%), 166 monitors (13%) and 32 displays (3%). Mobile computing accounts for 82% of all computers in secondary schools. Compared to primary schools, this is proportionately 13% lower and due mainly to a reduction in tablet use. The average ratio of computers to users is 1:1, while the average age of static computers is 6 years, mobile computers 5 years, monitors 6 years and displays 4 years.

For the SEND schools data for 1,870 EUC devices are captured, with 70 specific models of device from 11 brands identified. The data shows that an average SEND school has 151 computer users. In comparison, this is 43% of the size of a primary school and 14% of an average secondary school. Of these, 130 are students (86%) and 21 staff (14%). Therefore, the proportion of students as computer users in SEND schools is 3% lower than primary schools and 6% lower than secondary schools.

Each SEND school has an average of 245 devices, represented by 205 computers (84%), 38 monitors (15%) and 2 displays (1%). Compared to both primary and secondary schools, the mix is similar. This equates to an EUC asset portfolio of 109 notebooks (45%), 56 tablets (23%), 38 desktops (16%) and monitors, 2 AIO desktops (<1%), and 2 interactive displays (<1%). The proportional representation of notebooks is between 5-7% higher than previous results. While tablets are 9-25% lower than primary and secondary schools. The main reason is that desktop style devices are 10% higher than in primary schools and 3% higher than in secondary schools.

As such, mobile computing accounts for 68% in SEND schools compared to 95% in primary schools and 82% in secondary. The average age of static computers is 6 years, mobile computers 5 years, monitors 6 years and displays 5 years.

With 205 computers available per school, there are 1.3 computers per user in SEND schools. This exceeds both primary schools at 0.9:1 and secondary school at 1:1.

Table 1. Existing EUC asset profile results by school type

Statistic	Primary School	Secondary School	SEND School
Average number of computer users	348	1,091	151
Number of computers available per user	0.9	1	1.3
Percentage of mobile computers	95%	82%	68%
Percentage of static computers	5%	18%	32%
Desktops percentage of total	4.1%	13.1%	15.5%
AIO percentage of total	0.6%	1.3%	0.8%
Thin client desktop percentage of total	0.0%	0.5%	0.0%
Workstation percentage of total	0.0%	0.2%	0.0%
Notebook percentage of total	40.4%	37.8%	44.5%
Mobile thin client percentage of total	0.0%	0.0%	0.0%
Mobile workstation percentage of total	0.0%	0.0%	0.0%
Tablet percentage of total	48.3%	31.5%	56.0%
Monitors percentage of total	3.9%	13.1%	15.5%
Displays percentage of total	2.6%	2.5%	0.8%
Desktops average age	7	6	6
AIO average age	8	8	8
Notebooks average age	5	5	5
Tablets average age	5	5	5
Monitors average age	7	6	6
Displays average age	5	4	5

Current EUC Environmental and Financial Baseline by Schools Type

For an average primary school, an EUC estate consumes 6,859 kWh/y of electricity costing £2,126 per year with annual procurement costs of £34,794. The current annual carbon footprint generated by EUC devices is 12,835 $kgCO_2e$ (89% supply chain and 11% use-phase GHG emissions). This environmental impact is equivalent to emissions created by a combustion engine car travelling almost 76,000 km and requires 583 mature trees each year to remove the IT carbon from Earth's atmosphere. E-waste is 153 kg per year and the resulting End-user Emissions Volume Ratio (EVER) score is 1:39, meaning that for every device owned, 39 $kgCO_2e$ of GHG emissions is generated annually.

For an average secondary school, an EUC estate consumes 32,070 kWh/y of electricity costing £9,942 per year with annual procurement costs of £136,781. The current annual carbon footprint generated by EUC devices is 59,027 $kgCO_2e$ (89% supply chain and 11% use-phase GHG emissions). This environmental impact is equivalent to a car travelling over 347,500 km and requires 2,683 mature trees every year to remove the IT carbon from Earth's atmosphere. E-waste is 875 kg per year and the resulting EVER score is 1:46, meaning that for every device owned, 46 $kgCO_2e$ of GHG emissions is generated annually.

For an average SEND school, an EUC estate consumes 4,997 kWh/y of electricity costing £1,549 per year with annual procurement costs of £25,567. The current annual carbon footprint generated by EUC devices is 9,650 $kgCO_2e$ (89% supply chain and 11% use-phase GHG emissions). This environmental impact is equivalent to emissions created by a combustion engine car travelling over 56,800 km and requires 439 mature trees every year to remove the IT carbon from Earth's atmosphere. E-waste is 101 kg per year and the resulting EVER score is 1:39, meaning that for every device owned, 39 $kgCO_2e$ of GHG emissions is generated annually.

Table 2. Average school EUC estate annual environmental and financial results

Current Strategy	Annual Scope 3 Supply Chain GHG (kgCO2e)	Annual Scope 2 Use-Phase GHG (kgCO2e)	Total Annual Carbon Footprint (kgCO2e)	Annual Electricity Consumption (kWh)	Annual Electricity Cost (£GBP)	Annual Procurement Cost (£GBP)	Annual Potential E-Waste (kg)
Primary School Average	11,399	1,436	12,835	6,859	£2,126	£34,794	153
Secondary School Average	52,388	6,639	59,027	32,070	£9,942	£136,781	875
SEND School Average	8,616	1,034	9,650	4,997	£1,549	£25,567	101

Potential EUC Environmental and Financial Improvements by Schools Type

To reduce short and long term carbon footprint and cost impact, three key sustainable strategies will generate differing results. The first strategy outlined below is used to address the impending replacement of devices affected by the Windows EOL event [8] using circularity. The second is, extension of device lifespans to a uniform period of 8 years. Finally, the third is to introduce carbon footprint as a selection criterion for new device purchases.

Sustainable EUC Strategy 1: Lifespan Extension with Circularity, Windows 10 EOL

The data reveals 39% of Windows desktops (5 devices), 70% of Windows AIO computers (1 device) and 13% of Windows notebooks (6 devices) in primary schools were manufactured during or before 2017 and therefore will not meet the Windows 11 upgrade criteria [8]. Replacing these devices will generate 2,769 kgCO_2e of new product supply chain GHG emissions, 38.65 kg of e-waste and procurement costs of £7,388 per school. Extrapolated to a country level, this generates 46,419,516 kgCO_2e emissions; equivalent to driving 273.3 million km. This requires 2.1 million trees to sequester the resulting carbon from Earth's atmosphere. Additionally, 648 tons of e-waste will be produced; equivalent to 43.2 million aluminium soft drinks cans. The cost to replace the devices will be £123.9 million unless alternative action is taken.

For an average secondary school, 23 desktop computers, 9 AIO computers and 10 notebooks will not meet the Windows 11 upgrade criteria[8]. This will generate 9,875 kgCO_2e supply chain GHG emissions, 181 kg of e-waste and cost £26,958 if replaced. Extrapolated to a country level this will generate 34,088,500 kgCO_2e equivalent to 200.7 million km car miles and needing 1.55 million trees to sequester the carbon. Additionally, 624 tons of e-waste equivalent to 41.6 million aluminium soft drinks cans would be caused. The replacement will also cost £93 million.

In each SEND school, 1 desktop computer, 1 AIO computer and 5 notebooks will not meet the Windows 11 upgrade criteria[8]. This generates 2,004 kgCO2e kgCO_2e of supply chain GHG emissions, 32 kg of e-waste and cost £5,591 if replaced. Extrapolated to a country level this will generate 2,104,200 kgCO_2e of new product carbon footprint equivalent to driving 12.4 million km and needing 96,000 trees to sequester the carbon. Additionally, 33.6 tons of e-waste will be produced which is equivalent to 2.2 million aluminium soft drinks cans. The replacement will also cost £5.9 million.

Research shows that Windows device lifespan can be extended by replacing the existing operating system with Google's ChromeOS Flex [9-11]. Doing so creates devices similar to Chromeboxes and Chromebooks from the obsolete Windows 10 devices. Should all English state funded schools adopt this sustainable IT strategy, 82.6 million kgCO_2e carbon footprint, 1,306 tons of e-waste and costs of £222.8 million would be entirely avoided.

Sustainable EUC Strategy 2: Lifespan Extension to 8 Years

EUC equipment lifespan in schools varies from 5 to 8 years depending upon device type. Research indicates it is feasible for devices to be retained for a uniform 8 years. This is due to operating systems being supported for longer periods by vendors, alternative operating systems being viable and non-mechanical components improving mean time to failure (MTF) rates [12].

Extending device lifespans will not influence annual electricity consumption or costs because the same devices continue to operate. However, the practice does reduce average school annual supply chain carbon footprint, e-waste and procurement costs by an average of 34% as devices are replaced less often.

Table 3. Average school EUC estate annual environmental and financial results with lifespan extension to 8 years applied

Lifespan Extension 8-Year Strategy	**Annual Scope 3 Supply Chain GHG (kgCO2e)**	**Annual Scope 2 Use-Phase GHG (kgCO2e)**	**Total Annual Carbon Footprint (kgCO2e)**	**Annual Electricity Consumption (kWh)**	**Annual Electricity Cost (£GBP)**	**Annual Procurement Cost (£GBP)**	**Annual Potential E-Waste (kg)**
Primary School Average	7,411	1,436	8,846	6,859	£2,126	£22,285	101
Secondary School Average	33,479	6,639	40,118	32,070	£9,942	£88,765	534
SEND School Average	5,796	1,034	6,830	4,997	£1,549	£16,844	70

By extending device lifespans to 8 years, each primary school will avoid 3,988 kgCO_2e (35%) of supply chain emissions annually. Similarly, e-waste reduces by 52 kg (34%) to 101 kg per year and annual procurement costs reduce by £12,509 (36%). Using this strategy, the EVER score reduces from 1:39 to 1:27 meaning 12 kgCO_2e is avoided per device annually.

For each secondary school, 18,909 kgCO_2e (36%) of supply chain emissions are avoided annually. E-waste reduces by 341 kg (39%) to 534 kg per year and annual procurement costs reduce by £48,016 (35%). The EVER metric reduces from the current 1:46 ratio to 1:31, avoiding 15 kgCO_2e annually for each device owned.

Each SEND school will avoid 2,820 kgCO_2e (35%) of supply chain emissions annually. E-waste reduces by 31 kg (31%) to 70 kg per year and procurement costs reduce by £8,723 (34%). The EVER metric reduces from the current 1:39 ratio to 1:28. This means that by simply keeping devices for longer periods, 11 kgCO_2e is avoided on average annually for each device owned.

If all English state funded schools adopted this strategy, 135 million kgCO_2e of emissions would be avoided annually. This is equivalent to emissions caused by driving 795 million km and requires 6.1 million trees to sequester the carbon. Additionally, 2 million kg of potential e-waste would be avoided annually. This is equivalent to almost 138 million soda cans. Plus, £384.6 million in procurement costs would be avoided each year as equipment is replaced less often.

Sustainable EUC Strategy 3: Carbon Footprint as a Selection Criterion

The carbon footprint of EUC devices differs considerably. Today the lowest carbon footprint notebook available generates just 88 kg CO_2e [11] while the highest generates 772 kg CO_2e [11]. Both devices offer similar user experiences, yet the latter is 777% greater in GHG emissions. That's almost 9x worse for global warming and ultimately climate change. When compared to the current EUC initial cost based procurement strategies and varying retention strategies used in English schools, adoption of both uniform 8-year lifespans and including carbon footprint as a selection criterion has significant potential to improve both environmental and financial results.

Table 4. Average school EUC estate annual environmental and financial results with lifespan extension to 8 years and carbon footprint as a selection criterion

Lifespan Extension 8-Year Strategy + CFP as a selection criterion	Annual Scope 3 Supply Chain GHG (kgCO2e)	Annual Scope 2 Use-Phase GHG (kgCO2e)	Total Annual Carbon Footprint (kgCO2e)	Annual Electricity Consumption (kWh)	Annual Electricity Cost (£GBP)	Annual Procurement Cost (£GBP)	Annual Potential E-Waste (kg)
Primary School Average	4,311	1,222	5,533	5,903	£1,819	£22,285	82
Secondary School Average	19,491	5,803	25,294	27,271	£8,454	£88,765	415
SEND School Average	3,489	999	4,488	4,716	£1,462	£16,844	67

An average primary school reduces annual EUC carbon footprint by 7,302 $kgCO_2e$ (57%) via 62% supply chain and 14% use-phase emissions reduction. The EVER score declines from 1:39 to 1:17 while e-waste reduces by 46%. Finally, electricity consumption and cost declined by 14%, due to improved efficiency, meaning overall costs reduced by 35%, saving £12,816 per year.

For each secondary school, annual EUC carbon footprint reduces by 33,733 $kgCO_2e$ (57%) via 63% supply chain and 13% use-phase emissions reduction. The EVER score declines from 1:46 to 1:20 while e-waste reduces by 53%. Also, electricity consumption and cost declined by 15%, meaning overall costs reduced by 34%, saving £49,504 per year.

SEND schools average annual EUC carbon footprint reduces by 5,162 $kgCO_2e$ (53%) via 60% supply chain and 3% use-phase emissions reduction. The EVER score declines from 1:39 to 1:18 while e-waste reduces by 34%. Also, electricity consumption and cost declined by 4%, meaning overall costs reduced by 32%, saving £8,810 per year.

If all English schools adopted this joint strategy, 244 million $kgCO_2e$ of emissions would be avoided annually. This is equivalent to emissions caused by driving 1,439 million km and requires 11.1 million trees to sequester the carbon. Also, 2.8 million kg of e-waste is avoided annually. This is equivalent to almost 188 million soda cans. Plus, £395 million in costs would be avoided each year as energy efficiency improves and devices are replaced less often.

Summary

The results show that end user computing devices in the English state funded schools have a significant impact from both an environmental and financial perspective. Specifically, the current annual carbon footprint is 429,060 tons CO_2e GHG emissions, costs are £1.15 billion and e-waste is 5,691 tons.

This current pollution is equivalent to emissions created by driving a car 2.5 billion kilometres or 63,000 around the world every year. To remove this amount of carbon from the atmosphere requires 19.5 million trees for every year of operation. Based upon an average salary of £34,000 per annum, the current cost is equal to employing almost 34,000 teachers. Plus, the annual e-waste is equivalent in weight to 379.4 million soda cans.

During the one year project, evidence was found that schools do in some instances extend device lifespans to 8 years. This is currently restricted to AIO devices, although as these types of EUC devices include both a screen and computer, it is reasonable to suggest there is not a barrier to extending this to other device types. Schools also showed evidence that they were already using alternative operating systems such as Google's ChromeOS Flex to apply circularity strategies to devices that would otherwise be sent for end of life services. This too supports the concept of an 8 year retention period.

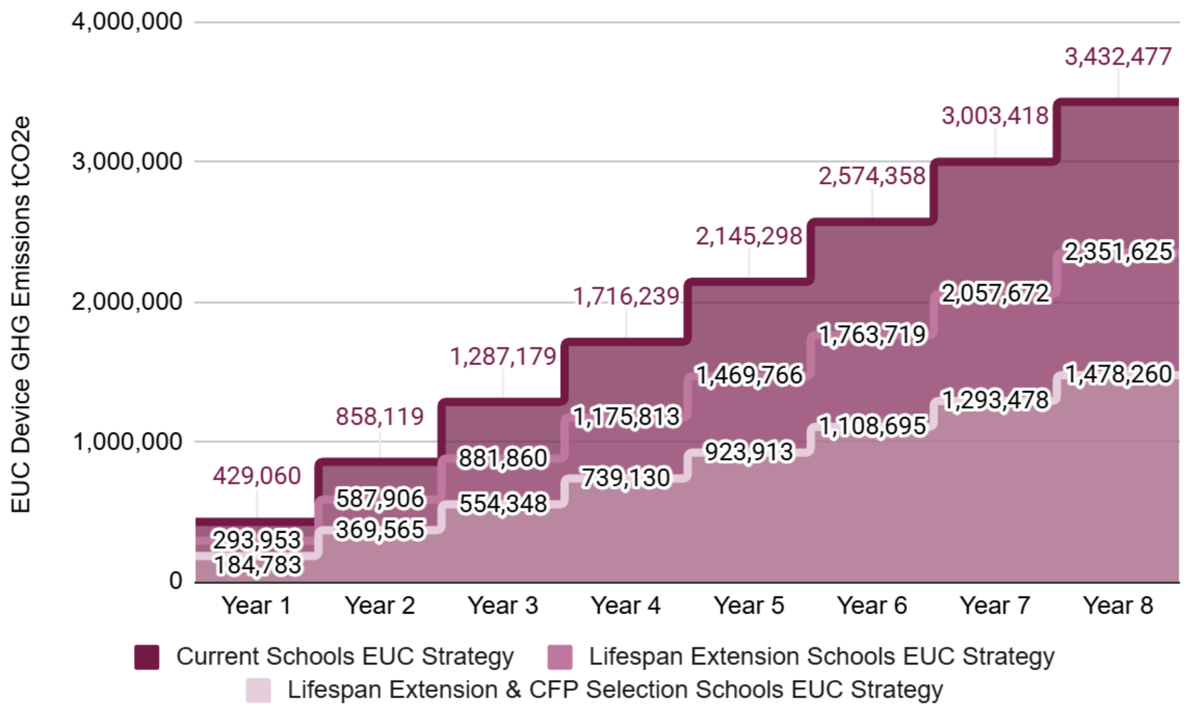
From a device selection policy, schools indicated that price and specification drives how EUC equipment is chosen and procured. Of the 233 schools, despite having recycling strategies to support climate action, no single organisation indicated that they had ever considered carbon footprint as a selection criterion. However, when shown how to achieve this using the Px^3 Compare application [6], it was indicated that each school was open to the concept.

Consequently, it is reasonable to suggest that sustainable IT strategies that can reduce 57% of the carbon footprint, 34% of costs and 50% of e-waste are worthy of consideration. As devices are replaced less often and selected for being low carbon footprint, the long term impact is significant.

As an example, across an 8 year period, 1,954,217 tons of cumulative EUC device GHG emissions can be avoided if the two sustainable IT strategies were adopted at a national schools level. That's equivalent to emissions caused by driving a combustion engine car 11.5 billion km or 287,000 times around the world. This amount of carbon would otherwise require

11.1 million trees for every year of operation to remove the pollution from Earth's atmosphere. Similarly, 22,511 tons of e-waste could be avoided; a weight equivalent to 1.5 billion soda cans.

Figure 1. Cumulative national schools EUC carbon footprint across 8 years by current and alternative sustainable IT strategies



Perhaps key to overcoming stakeholder resistance caused by interests that are financial rather than environmental [13], the two strategies have the capability of saving £3.16 billion during the 8 year period. This is equivalent to having sufficient extra funds to employ over 11,600 more teachers across the coming decade.

In conclusion, the objective of this project is met by defining a valid environmental and financial baseline for EUC operations in English schools and modelling sustainable IT strategies to substantiate potential improvements. Should these findings and actions be incorporated into national sustainable IT guidelines and frameworks by the DfE and UK government sustainability teams, the positive impact to the planet, public purse and climate policy is as undeniably meaningful.

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Supporting Organisations and People

The University of Warwick computer science faculty Professor Rob Procter, Dr Justin Sutton-Parker and head of department Yulia Timofeeva. Px^3 Limited Dr Justin Sutton-Parker, Department for Education (DfE) Chief Scientific Advisor Professor Russel Viner, DfE lead ICT advisors Jim Gardner and Chris Meaney, DfE ICT supporting advisors James Hatch, Steve Johnson and Craig Peppiatt, DfE Climate Change Unit David Wingate, DfE Digital Strategy Division Sofia Costa and Guy Paul, DfE Net Zero Accelerator Programme Sharon McHale, DfE DECBT Sustainability Team Gayle Boulton.

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About the Author

Dr Justin Sutton-Parker, was born in the 1970s and was initially awakened to the influence of anthropogenic interference to Earth's eco-system by authors such as Carson and Lovelock. A keen interest in environmental science subsequently introduced him to the work of the United Nations and particularly the events that led to the 1992 Earth Summit. A moment when the world recognised the threat posed by global warming.

During early roles working for global IT companies, such as Managing Chief Technologist for HP, Dr Justin turned his attention to computer science, recognising that the rapidly growing phenomenon of information technology would require stewardship as both devices and data centres consumed material resources, energy and water at an alarming rate.

With a PhD in computer science and a Masters in sustainability - both majoring in sustainable information and communication technology (ICT), Dr Justin has since become a leading voice in sustainable IT publishing in both scientific journals and mainstream media.

Dividing his time between commercial consulting, academic research and application development, Dr Justin is responsible for many sustainable IT world firsts. This includes pioneering research redefining the impact of human-computer interaction on active power draw and concomitant GHG emissions, invention of the 1st computer carbon footprint comparison application and invention of the 1st application platform capable of both scientifically quantifying IT carbon footprint at scale and modelling sustainable IT reduction strategies.

Dr Justin also founded specialist ICT carbon footprint consultancy Px^3 in 2013 and his research acts as the foundation for sustainable IT strategies for many global technology companies including Google and Microsoft. Additionally, Dr Justin contributes research to evolve assessment criteria for global IT eco-labels and national government sustainable ICT strategies.

It is therefore arguably unsurprising that Dr Justin has been a nominee for the world's most prestigious climate action award The Earth Shot Prize.